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Storage Tests on Florida Oranges, 1950

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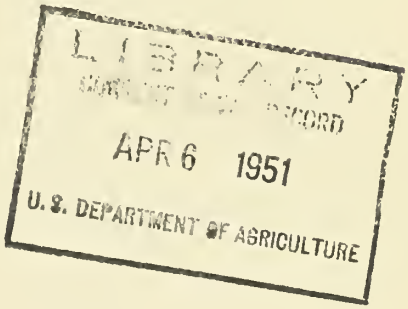

Division of Fruit and Vegetable Crops and Diseases

Report of a study made under the
Research and Marketing Act of 1946
Project No. 413

March 1951
Orlando, Florida
New York City, N. Y.

THE STORAGE OF FLORIDA ORANGES[1/]
ORLANDO, FLORIDA, AND NEW YORK CITY, N. Y.
1950

This is a report of the 1950 storage experiments with Valencia oranges conducted at Orlando, Florida, and New York City, N. Y. The tests were a part of the investigation on the storage of citrus fruits conducted by the Bureau of Plant Industry, Soils and Agricultural Engineering, and The Refrigeration Research Foundation.

Factors Affecting the Keeping Quality of Oranges in Storage

The purpose of placing fruits in cold storage is obvious. It is primarily to extend the marketing season and to bring about a more orderly handling of perishable crops. Glutted markets usually result in the lowering of prices. Risks are involved with storage of perishable crops, and sales prices must be high enough to justify the chances taken and the additional costs involved. The principal risks in the storage of oranges are the development of decay, skin breakdown, and declining prices. The latter may be due to poor storage quality or to the competition of other fruits or fruit products.

In this report results presented are from the 1950 storage of Florida Valencia oranges. Good storage results were obtained when the fruits were stored at 30° and 32°, for 8 to 12 weeks, and when relative humidity was maintained at 85 to 90 percent. High percentages of decay usually developed at 38° F. or during the 7-day holding period at 70°, following removal from storage. Skin breakdown in the form of pitting and aging was of minor importance and averaged from about 1 to 2 percent. During storage it was found that total solids, total acid, ascorbic acid, and percent juice, gradually decreased.

1/ Acknowledgement is due W. T. Pentzer, U. S. Department of Agriculture, Beltsville, Maryland, and H. C. Diehl, Director of The Refrigeration Research Foundation, Colorado Springs, Colorado, and to the following staff members of the Division of Fruits and Vegetables Crops and Diseases: Dr. B. A. Friedman, H. W. Hruschka, Jacob Kaufman, G. Lee Roberts, Charles Miller, Earl Nelson, and Robert Serros. Acknowledgement is also due the following growers, shippers, and cold storage warehouse officials for their generous cooperation: American Fruit Growers, Inc., George W. Boutilier, George Burton, Chase and Company, Randall Chase, Frank Chase, Sydney Chase, Paul B. Christensen, Haines City Citrus Growers Assn., Arnold Hampson, Corbett Hutchinson, W. Kinney, John T. Lesley, J. I. Lyle, III, Merchants Cold Storage and Warehouse Company at Providence, Rhode Island, Merchants Refrigerating Company at New York City, N. Y., Nevins Fruit Company, Orlando Citrus Growers Assn., J. J. Parrish, A. E. Pickard, R. V. Phillips, Waverly Growers Cooperative, Brantley A. Weathers, and Weathers Packaging Company.

The 4/5 bushel phenodor corrugated fiber-board cartons held up well under storage conditions, and in addition resulted in controlling decay slightly better than Bruce boxes with phenodor liners.

Storage tests were made to determine the keeping quality of oranges from various sources or groves. The variation in percent decay among these tests lots was not pronounced after 8 weeks storage. However, after 12 and 16 weeks it was very marked with low percentages of decay in lots designated as C, D, and E, and relatively high decay in lots B and G.

The effect of size of fruit on keeping quality was determined. It was found that decay was somewhat correlated with size. The highest amounts of decay were found in the very large fruits, size 126; while the lowest amounts occurred in the smallest fruits, size 250.

Rootstocks on which the trees were grown slightly affected Valencia oranges in storage. Those on rough lemon had slightly more decay than those on sour or sweet orange; however, the differences were small.

Storage tests were made to determine the effect on keeping quality of the following treatments as compared with untreated fruit: (a) ethylene only; (b) color-added only; and (c) ethylene-plus-color-added. The results showed that decay was less prevalent in lots of color-added only and ethylene-plus-color-added than in the controls and the ethylene only lots, and more decay was found at 38° than at 30° or 32° storage.

Tests were made on holding time and temperature following removal of oranges from storage. The studies were too limited to permit more than tentative conclusions: however, the data showed a striking increase in amounts of decay between the third and seventh day at 70° F. or higher. They also showed the advisability of returning stored fruit to low temperatures after it had been exposed to high temperatures. The data further suggested that if practicable it would be advantageous to reduce the marketing period (i.e. the period during which the fruit would be subjected to warm temperatures) for stored fruit to a maximum of two days.

A low temperature injury was observed. Affected fruits were somewhat soft, flabby, and had a water-soaked appearance over the entire surface. The affected oranges were found at 32° as well as 30° storage. The injury was believed to be a form of storage or low temperature breakdown rather than a freezing injury.

As a part of the project a study was made on the storage of 11 cars of Florida grapefruit and oranges at terminal markets. The carlots of fruit were shipped during April and May, 1950, and storage was at either New York (Jersey City, N. J.), or Providence, R. I.

Each carlot was handled in a strictly commercial manner, however, complete information was obtained as to the history of the fruit from the time it was picked until sold. Grapefruit storage was successful for only 4 weeks because of pitting but oranges were held in good condition for 12 weeks. The temperature in the commercial storages averaged about 32° F. with relative humidity at 85 to 90 percent. The amount of decay found in the various carlots of oranges was associated

with the source of the oranges and length of the storage period.

It was not possible to make direct price comparisons between the fruit marketed on the day of storage with comparable fruit sold after storage. It may be stated that the 3 cars of grapefruit after storage sold for an average of $3.32 per box, and the 8 cars of oranges after various storage periods for an average of $5.46 per box.

Material and Methods

The fruit for the tests, unless specified, was limited to sizes 150 and 176, and was packed in standard Bruce boxes with phenodor treated case liners. The oranges for these studies were obtained from 7 different shippers and were representative of the commercial pack and quality being marketed at that season of the year. In addition, a number of special storage tests were prepared with the cooperation of Chase and Company and the fruit for these studies was obtained from their Isleworth grove located at Windermere, Florida. Other tests were with the Weathers Packaging Service of Orlando, Florida, and the fruit was packed by the Haines City Citrus Growers Assn., at Haines City, Florida.

At Orlando and at New York City 3 cold storage rooms were set at temperatures of 30°, 32° and 38° F. The rooms were checked frequently and a continuous record was obtained by hygro-thermographs. Except for minor fluctuations the temperatures for the most part held within a narrow range. In New York the 30° F. room averaged 30.4°; the 32° F. room 32.6°; and the 38° room, 39.7° F. At Orlando there was a breakdown of the refrigeration plant on July 17th. Steps were immediately taken to make the necessary repairs, but when this failed it became necessary to transfer all of the tests lots to one commercial storage room that was maintained at 32° F. The fruit warmed up during the attempted repairs and transfer and it is very probable that this influenced the final results. The authors wish to point out that the percentages of decay would have likely been somewhat smaller had the breakdown not occurred.

Methods of procedure and of inspections of fruit, unless indicated otherwise, were identical with those used in the tests of 1949. In scoring the several types of skin breakdown, a given fruit showing both aging and pitting was scored under the defect that was considered the more serious blemish. Decay was always considered more serious than any type of skin breakdown. Decayed fruits were scored under stem-end rot when their symptoms were characteristic of Diplodia rot or Phomopsis rot, even though the decay occurred elsewhere than at the stem end. Three inspections were made; namely, at the time the boxes were removed from storage, 3 days after removal, and 7 days after removal. During this 7-day holding period the temperature was 70° F. and the relative humidity 85 to 90 percent.

As a result of two previous seasons' storage experiments it was concluded that a 7-day holding period at 70° F. was too severe a test for fruit removed from cold storage; that stored fruit might normally be expected to move through marketing channels and reach the consumer during the first 3 days after removal from storage. The results of the 3-day inspections are therefore considered to have far greater

significance than those of the 7-day inspection. It might be pointed out, however, that the 7-day inspection was retained for the purpose of correlating the present season's results with those of 1948 and 1949.

The phenodor (diphenyl-treated) liners were removed at the first inspection. Decayed fruits were removed and discarded at the first and second inspections before repacking the test boxes. The amount of decay recorded for the second and third inspections is cumulative; that is, it includes decay counts for all previous inspections. Pitting and aging records of the second inspection and commercial breakdown of the third inspection are not cumulative, but instead are based on actual counts made at the particular inspection. The term "commercial breakdown" is equivalent to the total of moderate and severe aging and moderate and severe pitting. It should be noted that decays other than stem-end rots and Penicillium rots are not listed by specific types, but are with total of decay in each instance. Thus, total decay may be greater than the sum of decay attributed to stem-end rot and Penicillium rot.

Samples of 25 oranges (size 150) were used for chemical analyses and taste tests. The fruits were taken at the time of the second and third inspections, and the determinations were made in duplicate on the composited juice. In order to be able to calculate cumulative percent decay for all 3 inspections, it was necessary to apply a correction factor to decay records of the 7-day inspection for those boxes from which samples were removed for juicing. In doing so, it was assumed that had the 25 fruits been held for the additional 4-day period they would have become affected with decay in the same proportion as those not so removed.

RESULTS AT ORLANDO, FLORIDA

Effect of Storage Temperature on Decay, Pitting, Aging, and Composition

Equally good results were obtained when oranges were stored at 30° and 32°, whereas high percentages of decay developed during storage at 38° F. It will be noted in figures 1 and 2 that insignificant to small amounts of decay developed during 8 and 12 weeks at 30° and 32° F. Much decay developed during storage at 38° and during the 7-day holding period at 70°. Attention has been called to this 7-day holding period and figure 2 shows the development of decay during this time. It will be observed that comparatively small amounts of decay developed during the first 3 days at 70°, but the amount increased rather rapidly between the third and seventh day. The results (fig. 2) also indicate that decay increased with the length of storage, being much higher after storage for 16 weeks than after storage for 12 or 8 weeks.

Skin breakdown in the form of storage pitting or aging was of minor commercial importance and severe pitting seldom reached 1 percent (fig. 3).

The percentages of fruit that showed aging were small, but somewhat greater than those showing pitting. The results on aging are presented in figure 4 and it will be seen that less than 1.5 percent developed during storage. More aging developed during the 7-day holding period at 70° F. but averaged only about 2 percent.

Chemical analyses were made on the juice of Valencia oranges to determine the changes in internal composition of the fruit during storage. Some of these data have been summarized, and the results are graphically presented in figure 5. It will be seen that most of the chemical constituents followed definite trends and that total solids, total acid, ascorbic acid and percent juice decreased with storage. Different storage temperatures appeared to have little influence on composition. It did, however, affect the flavor of the juice and the taste tests showed that fruits from 30° and 32° storage were more favorably rated than those from 38° storage. The loss in weight was calculated. There appeared to be very little difference between 30° and 32° while the greatest loss was noted with storage at 38°. For example, at 32° loss of weight after 8 weeks storage generally averaged about 1.2 percent; after 12 weeks storage, 2 percent; after 16 weeks, 3.2 percent. At 38° loss of weight after 8 weeks storage amounted to 2.5 percent; after 12 weeks, 4.7 percent; and after 16 weeks, 6.2 percent.

Phenodor Treated Corrugated Fiber Containers Versus Phenodor Case Liners

A series of storage tests were conducted in which comparisons were made between the phenodor treated fiber container and the phenodor case liner. The 2 test lots of fruit were packed by 1 shipper from the same crop of fruit. Each lot consisted of 20 boxes of fruit and storage was at 30°, 32°, and 38° F. Inspections on the fruit were made at the end of each storage period and twice during the holding test at 70° F. The fruit and containers used in these storage tests were furnished by the Weathers Packaging Service and packed by the Haines City Citrus Growers Association.

The standard 4/5 bushel phenodor corrugated fiber carton held up in storage remarkably well. The cartons were easy to handle since they were only half as large as the standard Bruce box. Results on keeping quality of the fruit showed slightly smaller amounts of decay in the phenodor cartons than in the phenodor linered Bruce boxes. Some of these data are presented in figure 6. Less decay developed at storage temperatures of 30° and 32° than at 38° F.

Effect of Grove Variation on Storage Quality

Storage tests were made to determine the keeping quality of oranges from various sources. The test lots consisted of fruit from 9 different groves and were stored for 8, 12, and 16 weeks at 30°, 32°, and 38° F. Each lot consisted of 20 boxes of fruit representing the quality and pack going to market. Eight lots were packed in standard 1-3/5 bushel Bruce boxes with phenodor case liners, while the remaining lot was packed in standard 4/5 bushel phenodor treated corrugated fiber cartons. The fruit was inspected at the end of each storage test and twice during the 7-day holding period at 70° F.

The results of these tests indicate considerable variation in storage quality among lots or groves. It will be seen in figures 7 and 8 that percent total decay after 12 and 16 weeks of storage was usually low in lots C, D, and E, while higher percentages of total decay were found in B and G. There did not appear to

be very much difference in percentage decay between storage at 30° and 32° F. Differences, however, were found between 32° and 38° storage, with much higher percentages of decay developing at the latter storage temperature.

Effect of Size of Fruit on Decay in Storage

Storage tests have been made to determine the effect of size of fruit on storage quality. These tests included 6 boxes of fruit of the following sizes: 126, 150, 176, 200, 216, and 250. Storage was for 8 and 12 weeks at 32° F. The oranges were inspected at the end of each period and twice after transfer to 70° F.

It may be seen in figure 9 that small amounts of decay developed during 8 weeks and 12 weeks storage at 32° F. and that decay was insignificantly influenced by size. Most of the decay occurred during the holding test at 70° F. and developed largely between the third and seventh day. In this connection, it may be observed that decay was to some extent correlated with the size of the fruit, the highest amounts of decay being found in the very large fruits, size 126; while the lowest amounts were found in the smallest fruits, size 250. The data were not always consistent and the most striking inconsistency was the rather low percentages of decay found in size 150.

Chemical analyses were made on these fruits to determine the effect of size on composition. Some of these data are summarized in figure 10. It may be observed that size of fruits did not affect percent juice per fruit. It did, however, affect the total solids, total acid and ascorbic acid content in that lower amounts were associated with the larger fruits and higher amounts with the smaller fruits. It may also be noted that the total acid, ascorbic acid, and percent juice per fruit decreased with length of storage while total solids increased.

The Relation of Rootstocks to Storage Quality

Tests were made to determine the keeping quality of Valencia oranges grown on rough lemon, sour orange, and sweet orange rootstocks. The fruit was obtained from Chase and Company and came from their groves located at Windermere, Florida. Each storage lot consisted of 20 boxes and the fruit was stored for 8, 12, and 16 weeks at 30°, 32°, and 38° F. The fruits were examined at the end of each storage period and twice during the holding test at 70° F.

In these tests, rootstocks affected the keeping quality of the fruit in that slightly more decay was found in the Valencias grown on rough lemon than in those grown on sweet or sour orange rootstocks. The results on total decay are shown in figure 11. The original data showed that small amounts of decay occurred during storage at 30° and 32°, while greater amounts were found at 38° F. Total decay increased with the length of the storage period and was regarded of economic importance when the storage was extended from 12 to 16 weeks.

RESULTS AT NEW YORK, N. Y.

Relation of Color-added and Ethylene Treatments to Storage Behavior

Studies were conducted to determine the effect of ethylene and color-added as prestorage treatments on the keeping quality of stored fruit at 30°, 32°, and 38° F., respectively. The test consisted of 4 lots of fruit of 20 boxes each as follows: (a) control - treated with neither ethylene nor color-added, (b) ethylene only, (c) color-added only, and (d) ethylene plus color-added. The ethylene treatment was for 43 hours at a temperature between 80° - 85°, and the color-added solution was held at 128° F., where used. All lots of fruit passed through the soaking tank which contained Dowicide A; liquid soap was used in washing. The 4 lots were waxed with Food Machinery Company "Flavorseal" (fog wax). Precooling was for 45 hours and the test fruit was shipped with other fruit in car FGEX 57746 under refrigeration (Section 2, Rule 80). Ryan recording thermometers, located in bottom and top doorway packages, showed practically identical temperatures; namely, a fairly gradual drop from 88° F. at noon of April 26 to about 50° F. at time of loading on April 28th. During the transit period the temperature dropped slowly to 42° at the time of unloading on May 2, with a further drop of 2 degrees between time of unloading and the time the test boxes were placed in the different storage rooms on May 4.

Inspections on the fruit were made at the end of 8, 12, and 16 weeks storage, and twice during the holding period at 70° F.

The findings showed that relatively little decay or skin breakdown occurred during storage for 8 or 12 weeks at 30° or 32° or during the 3 day period at 70° F. following removal from storage. Rather high amounts of decay were present in all lots stored at 38° F. for 12 and 16 weeks. (See figure 12.) During the holding tests at 70° decay increased to such an extent as to make 38° storage impractical.

From the start to the end of the test, the fruit treated with color-added (either alone or with ethylene) had the deepest orange rind color, and the control lots the greenest. Other than that, there was no distinguishable difference in appearance, firmness, or freshness among treatments. A careful examination of the data showed that severe aging and pitting were generally more prevalent in the fruit treated with ethylene, particularly where ethylene was used in conjunction with color-added.

Data on the juice characters showed a general uniformity among treatments, storage temperatures, and length of the storage period. The exception was that flavor was generally rated as fair, instead of good, when storage was extended to 12 and 16 weeks.

There was likewise a general uniformity in loss in weight. The results show there was an average loss of 2.3 percent at 8 weeks; 3.2 percent at 12 weeks; and 4.0 percent at 16 weeks storage.

Attention should be called to a low temperature storage injury that occurred

at 30° and 32° F., but was more serious with fruits stored at the lower temperature. The affected oranges were somewhat soft, flabby, and had a water-soaked appearance of the entire surface. Distribution of these affected fruits was as follows: 2 percent in 2 of the 8 boxes withdrawn after 8 weeks storage at 30° F.; none in storage lots at 32° F.; 2.5 percent in 5 of 8 boxes withdrawn after 12 weeks at 30° F.; 1.5 percent in 2 of 8 boxes stored at 32° F. Injured fruits were found in all 8 boxes after 16 weeks storage at 30°, with 3 percent noted at the first inspection and cumulative totals of 5 and 6 percent at second and third inspections, respectively. At 32° affected fruits were found in all 8 boxes which averaged about 2 percent, and was most evident at the time of the second inspection.

So far as could be determined the temperature in the 30° room never dropped low enough to cause freezing. At the same time it is recognized that this possibility has to be considered. The fact, however, that affected oranges were found scattered through the box, and that the condition was also observed in lots stored at 32°, as well as 30°, indicates that the water-soaked condition was a form of storage - or low-temperature breakdown, rather than freezing injury.

From an overall picture of the test it would appear that best results were secured by storage at 32°, rather than at either 30° or 38°. At 32°, the 12 week storage period was entirely successful. On the basis of condition only at time of removal, storage was successful for the 16 weeks. However, decay increased rapidly during the 3-day holding test at 70° and the results indicated that 16 weeks was too long a storage period for this fruit.

Relation of Rootstock to Storage Behavior

Tests were also conducted in New York, N. Y. to determine the storage behavior of fruits grown on rough lemon and sour orange rootstocks. The test packages consisted of 2 test lots of 20 boxes each and storage was for 8, 12, and 16 weeks at 30°, 32° and 38° F. Inspections on the fruit were made at time of removal from storage and after 3 and 7 days at 70°.

Packing house treatments were the usual ones. The fruit was washed, waxed, and polished. The test fruit was shipped to New York with other fruit in car WFEX 71076 under refrigeration (Section 2, Rule 80). During rail transit, the temperature in the car was reduced from 62° to 50°.

The results presented in figure 13 show that the rootstocks on which the oranges were grown affected total percentage of decay. It may be observed that slightly lower amounts occurred in storage and during the 3-day holding test when the Valencias were grown on sour orange rather than rough lemon rootstock. The differences were small but were in agreement with other results presented earlier in this report.

There are other points that should be mentioned. For example, slightly less decay occurred at 32° than at 30° and as would be expected total decay increased with length of storage. Very high percentages of decay developed at 38° storage as was the case in tests made in Orlando.

There was little correlation between rootstocks and the small amount of skin breakdown that was found. Severe pitting and aging seldom exceeded 2 percent and were generally regarded as too small to have economic importance.

Comparison of Holding Temperatures Following Removal of Oranges from Storage

Storage tests were conducted at New York City to determine the rate of increase in decay in oranges held at different temperatures following storage. Twenty-eight boxes of fruit were used in the studies and 2 tests were made, one after 7 weeks storage, the other after 14 weeks, both at 32° F. The procedure after storage was as follows: (a) fruit was held continuously at 80° to 85°; (b) at 70°; (c) in a home refrigerator at 40° to 45° after previous storage for 2, 3, and 4 days at 70°. The fruit was inspected for decay at the time it was removed from 32° storage. During the holding period it was inspected daily, for the most part, for a one week period. Decayed oranges were removed at each inspection.

Comparatively little decay was found at the initial inspection (after 7 weeks' storage at 32°). The fourth day's inspection showed somewhat greater amounts of decay in those boxes of fruit which were held continuously at high temperatures (70° and 80° to 85°), and decay increased during the remainder of the 7-day holding period. There was little difference between the lots transferred to 40-45°, after 2, 3, or 4 days holding at 70°. However, much less decay was found in this fruit transferred to 40°to 45° than in those lots that were held continuously at high temperatures. (See figure 14.)

More pronounced differences were found among lots in the test conducted after 14 weeks' storage (compare A with B in figure 14). Decay developed rapidly in the fruit that was held continuously at high temperatures (70° and 80° to 85°), after removal from storage. Considerable decay developed in 3 and 4 days at 70° before the oranges were transferred to 40° to 45°, and there was little difference between the fruit held 3 and 4 days in respect to decay development. Much less decay was found in the lot that was transferred after 2 days at 70°. This lot of fruit had a low decay count at the time of the initial inspection, and again after 2 days at 70°, suggesting fewer infected fruits at the start of the test. Thus, the lot did not appear typical of the whole.

These tests were too limited in scale to permit more than tentative conclusions.

The data do show the striking increase in decay between the third and seventh day at 70° and 80° to 85° F. They also show the advisability of using refrigeration in the store and home to prevent decay of oranges removed from cold storage. The data further suggest that if practicable it would be advantageous to reduce the marketing period (i.e. the period during which the fruit would be subjected to warm temperatures) for stored fruit to a maximum of 2 days.

COMMERCIAL STORAGE OF ELEVEN CARS OF FLORIDA GRAPEFRUIT AND ORANGES AT NEW YORK AND PROVIDENCE

As a part of the project on the storage of citrus fruits, a study was made on the storage of 8 cars of Florida oranges and 3 cars of Florida grapefruit (a total of 5,775 standard 1-3/5 bushel Bruce boxes). The carlots of fruit were shipped during April and May 1950 and storage was at either New York (Jersey City, N. J.), or Providence, Rhode Island.

The study was made through the mutual cooperation of various shippers and their sales representatives, Merchants Refrigeration Company, New York, N. Y., Merchants Cold Storage and Warehouse Company, Providence, R. I., Messrs. H. C. Diehl, Director of The Refrigeration Research Foundation, and W. T. Pentzer and other representatives of the U. S. Department of Agriculture.

Each carlot of fruit was handled in a strictly commercial manner, and complete information was obtained as to the history of the fruit, packing-house treatment, and shipping conditions. Inspections of the fruit were made at the time the cars were unloaded and periodically during storage. Usually at each inspection 4 boxes of representative sizes were taken to the Market Pathology laboratory at New York City, where the phenodor liners were removed and discarded. The fruit was examined, decayed fruit removed, and the sound fruit repacked and placed at 70° F. for inspections after 3 and 7 days. The boxes of fruit from the Providence cars were shipped by refrigerated truck, giving overnight service to the New York laboratory.

The shippers and their sales representatives were kept informed of the condition of the stored carlots of fruits and in some instances were advised to move the fruit out of storage because of the development of pitting or decay. Otherwise, no attempt was made to influence the shipper as to length of storage.

It might be pointed out that although the present report deals with the storage of oranges the information on storage behavior of the 3 carloads of grapefruit is included since the cars were stored under the same research program. Because of pitting of the rind, storage of the grapefruit in all 3 carloads was successful for only 4 weeks. Two cars were removed after that storage period. A third was held in storage 8 weeks with the result that pitting was much more serious when these fruits were removed. The 3 cars sold for an average of $3.32 per box.

It will be noted that the 8 carloads of oranges were stored for varying periods ranging from 5 to 12 weeks with an average of 8 weeks. Although the data are not shown in the table it may be stated that commercially important skin breakdown (pitting and aging) averaged no greater than 1 percent in each of 4 carloads of oranges at the time of removal from storage. In the other 4 cars it averaged 2 percent in car J, 3 percent in car G, 4 percent in car H, and 2 to 8 percent in car D. The amount of decay found in the various carlots of oranges ranged between 0.5 percent to 5 percent and was associated with the source of the oranges and the length of the storage period. The 8 carloads of oranges sold for an average of $5.46 per box.

Pertinent data are summarized in table 1.

TABLE 1.--Records on the Commercial Storage of 11 Cars of Florida Grapefruit and Oranges
1949-1950 Season

SHIPPER	SHIPPING POINT	KIND OF FRUIT	CAR NUMBER	BOXES	LENGTH OF STORAGE	DATE OF SALE	AVERAGE SELLING PRICE
	Florida				Weeks	1950	Per Box
A	Clermont	Duncan Grapefruit	NP-91419	525	4 1/	May 17	$3.55 & $3.93
B	Clermont	Duncan Grapefruit	WFEX-68255	525	8 2/	About June 12	$3.50
C	Orlando	Marsh Grapefruit	WFEX-66418	525	4 1/	June 28	$2.57 & $3.80
D	Orlando	Valencia Oranges	BREX-74422	525	5 2/	June 28,29,30	$5.35
E	Waverly	Valencia Oranges	WFEX-71107	525	6 1/	June 21	$4.47
F	Clermont	Valencia Oranges	BREX-74453	525	9 1/	July 19	$4.78
G	Isleworth	Valencia Oranges	BREX-74675	525	11 1/	August 3	$5.37
H	Isleworth	Valencia Oranges	WFEX-71089	525	5 2/	June 30	$6.05
I	Orlando	Valencia Oranges	FGEX-59655	525	12 1/	August 17	$5.66
J	Orlando	Valencia Oranges	ART-27220	525	12 2/	August 16	$6.04
K	Haines City	Valencia Oranges	WFEX-66524	525	5½ 1/	About July 7	$6.00

1/ Merchants Refrigerating Co., New York, N. Y.

2/ Merchants Cold Storage and Warehouse Co., Providence, R. I.

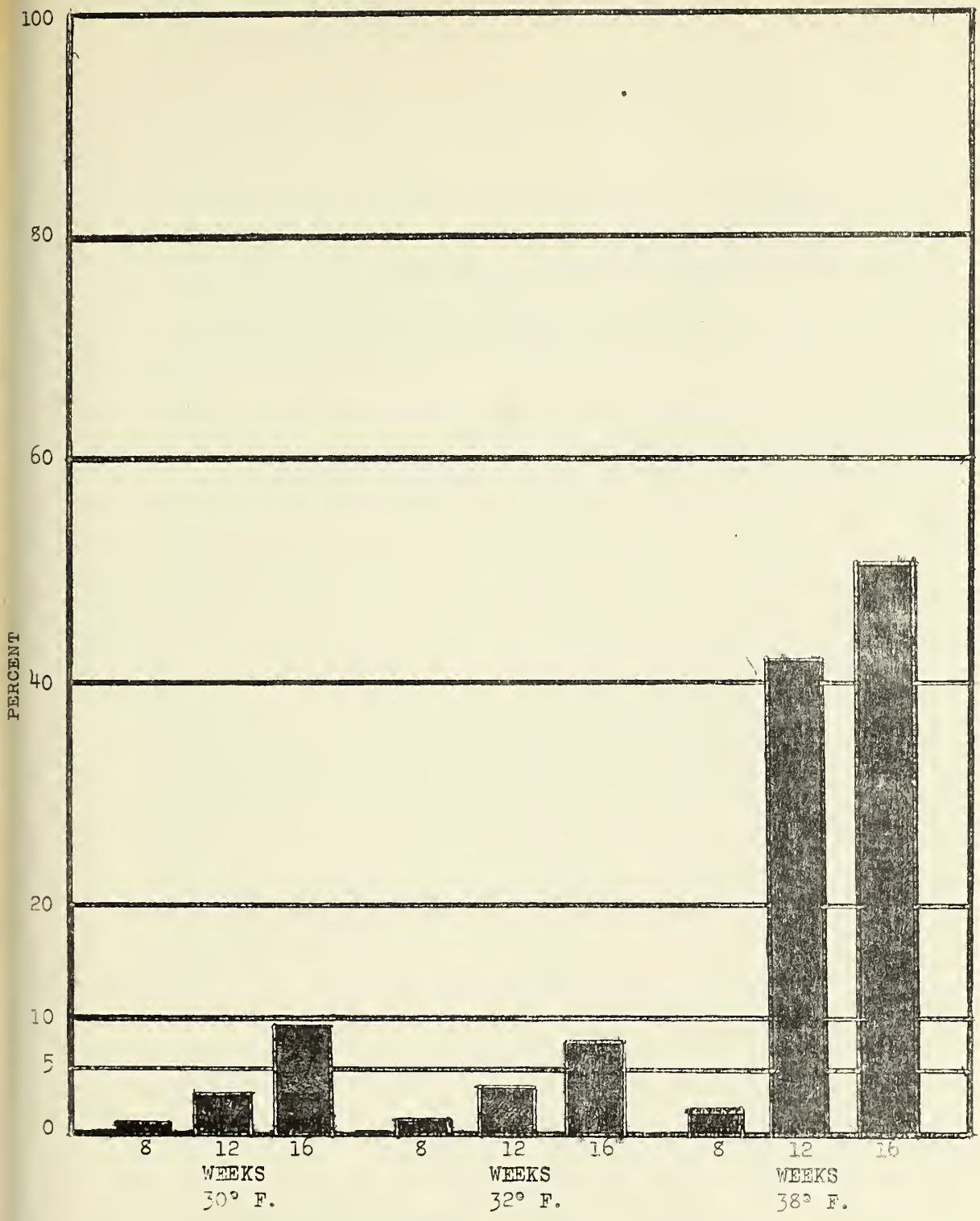

FIGURE 1.--DEVELOPMENT OF DECAY IN COLD STORAGE. (PERCENTAGES BASED ON AVERAGES FROM 9 DIFFERENT TEST LOTS.)

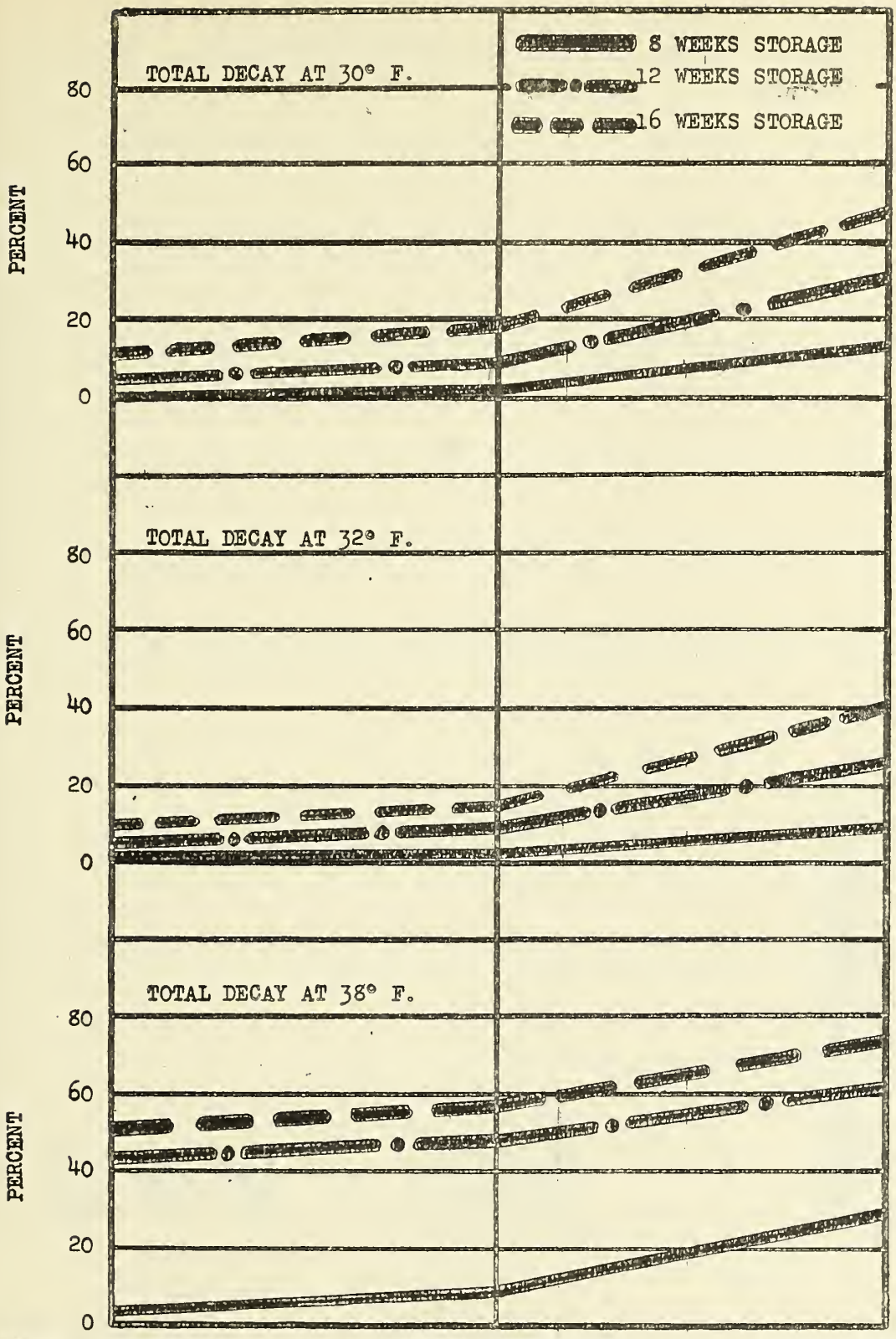

FIGURE 2.—THE DEVELOPMENT OF DECAY DURING THE HOLDING PERIOD FOLLOWING COLD STORAGE. (PERCENTAGES BASED ON AVERAGES FROM 9 DIFFERENT TEST LOTS.)

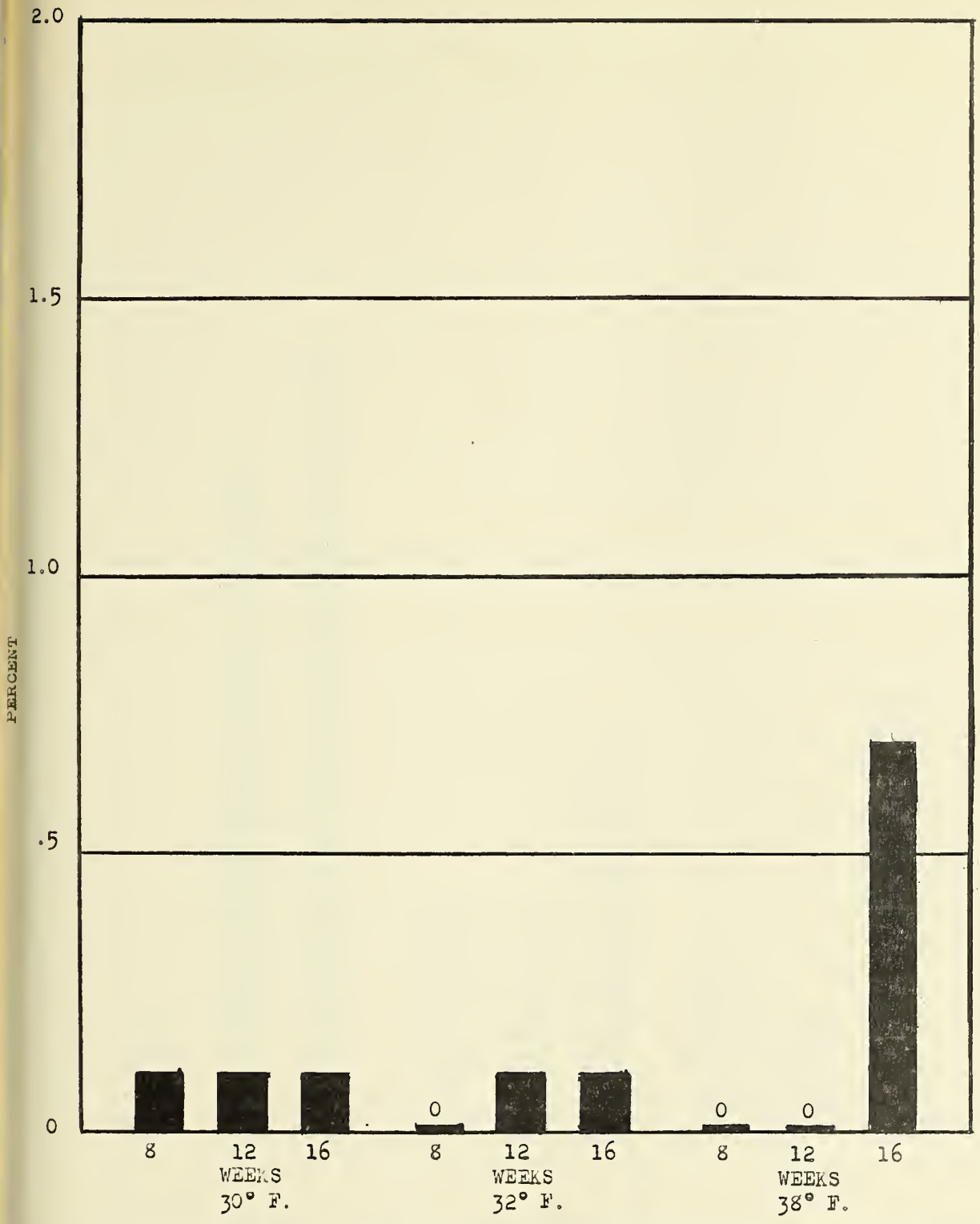

FIGURE 3. --DEVELOPMENT OF PITTING IN COLD STORAGE. (PERCENTAGES BASED ON AVERAGES FROM 9 DIFFERENT TEST LOTS.)

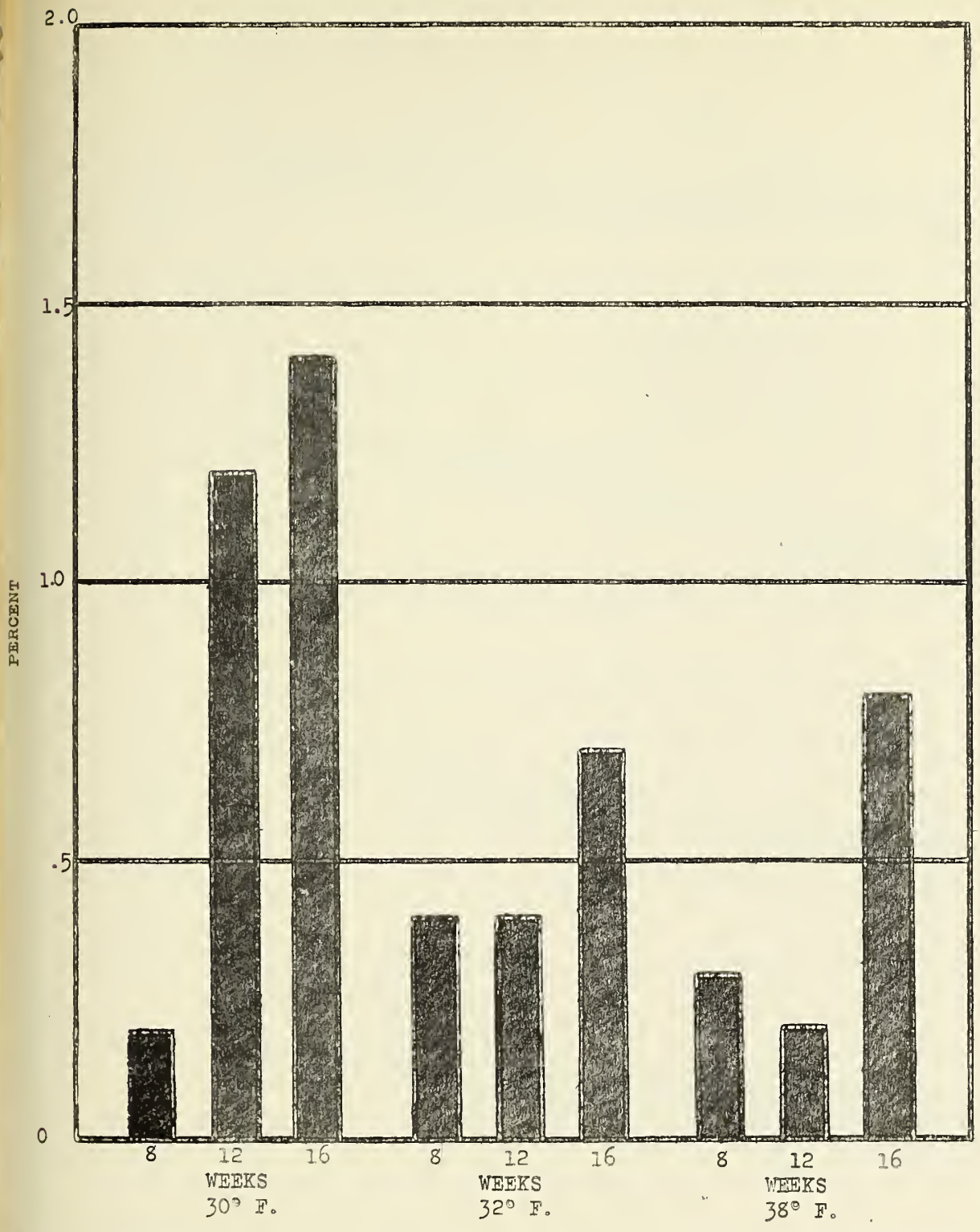

FIGURE 4.--DEVELOPMENT OF AGING IN COLD STORAGE. (PERCENTAGES BASED ON AVERAGES FROM 9 DIFFERENT TEST LOTS)

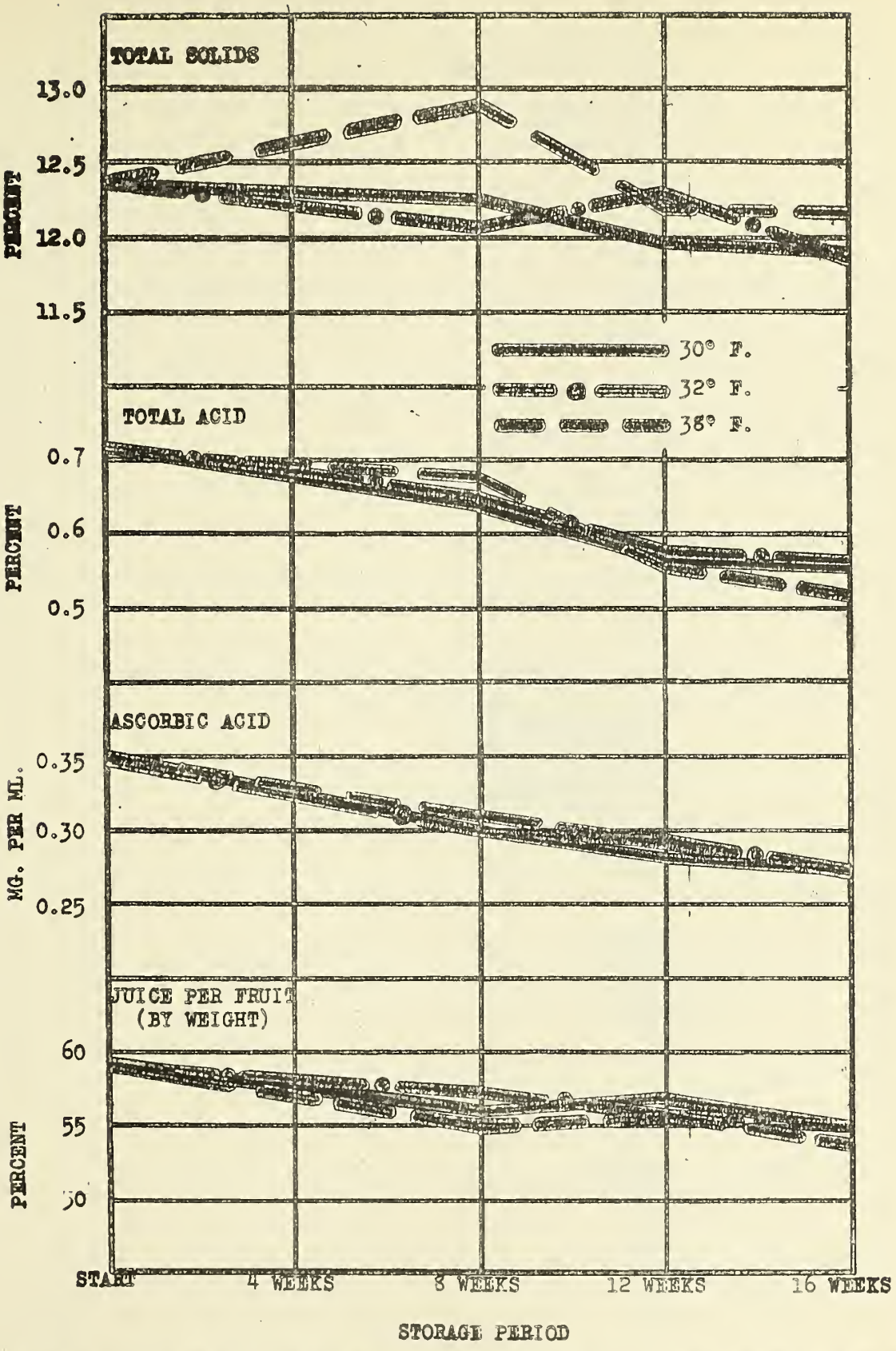

FIGURE 5.—CHANGES IN THE COMPOSITION OF VALENCIA ORANGES ON ROUGH LEMON ROOTSTOCK DURING STORAGE. (PERCENTAGES BASED ON AVERAGES FROM 5 DIFFERENT LOTS.)

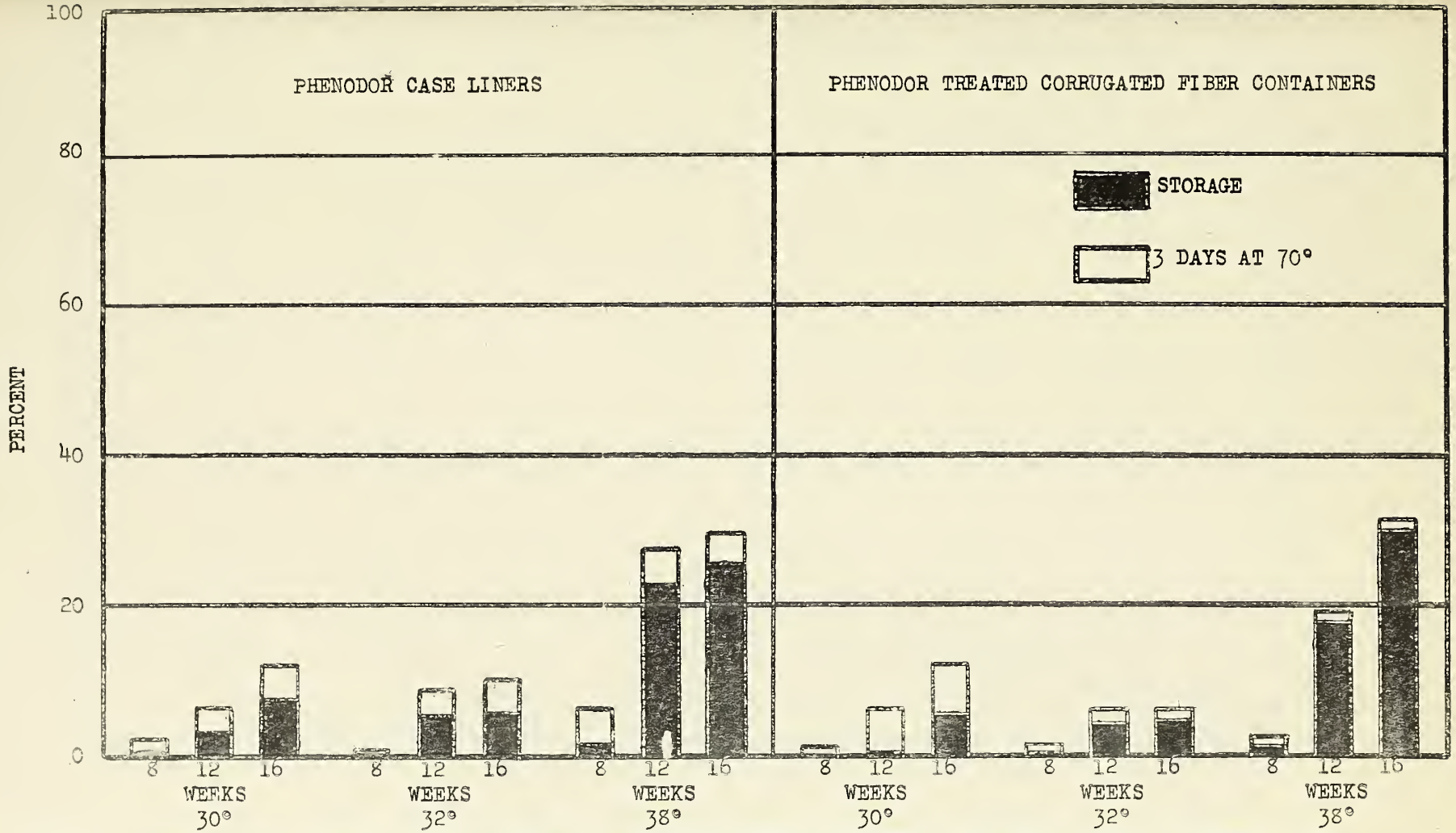

FIGURE 6.--THE CONTROL OF DECAY DURING STORAGE COMPARING PHENODOR TREATED CORRUGATED FIBER CONTAINERS WITH PHENODOR CASE LINERS.

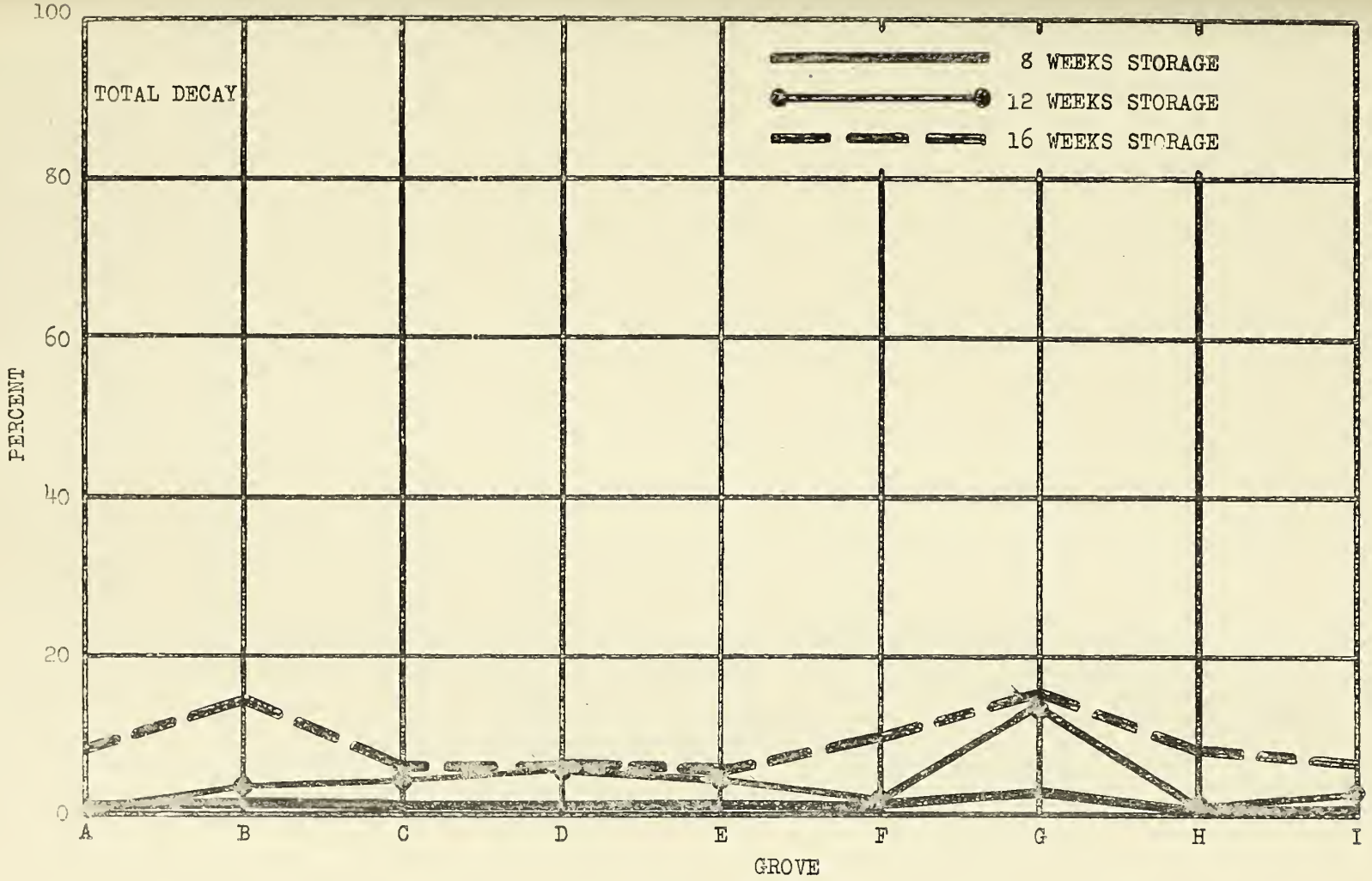

FIGURE 7.--EFFECT OF GROVE VARIATION ON DECAY IN STORAGE. FIRST INSPECTION AFTER REMOVAL FROM 32° F.

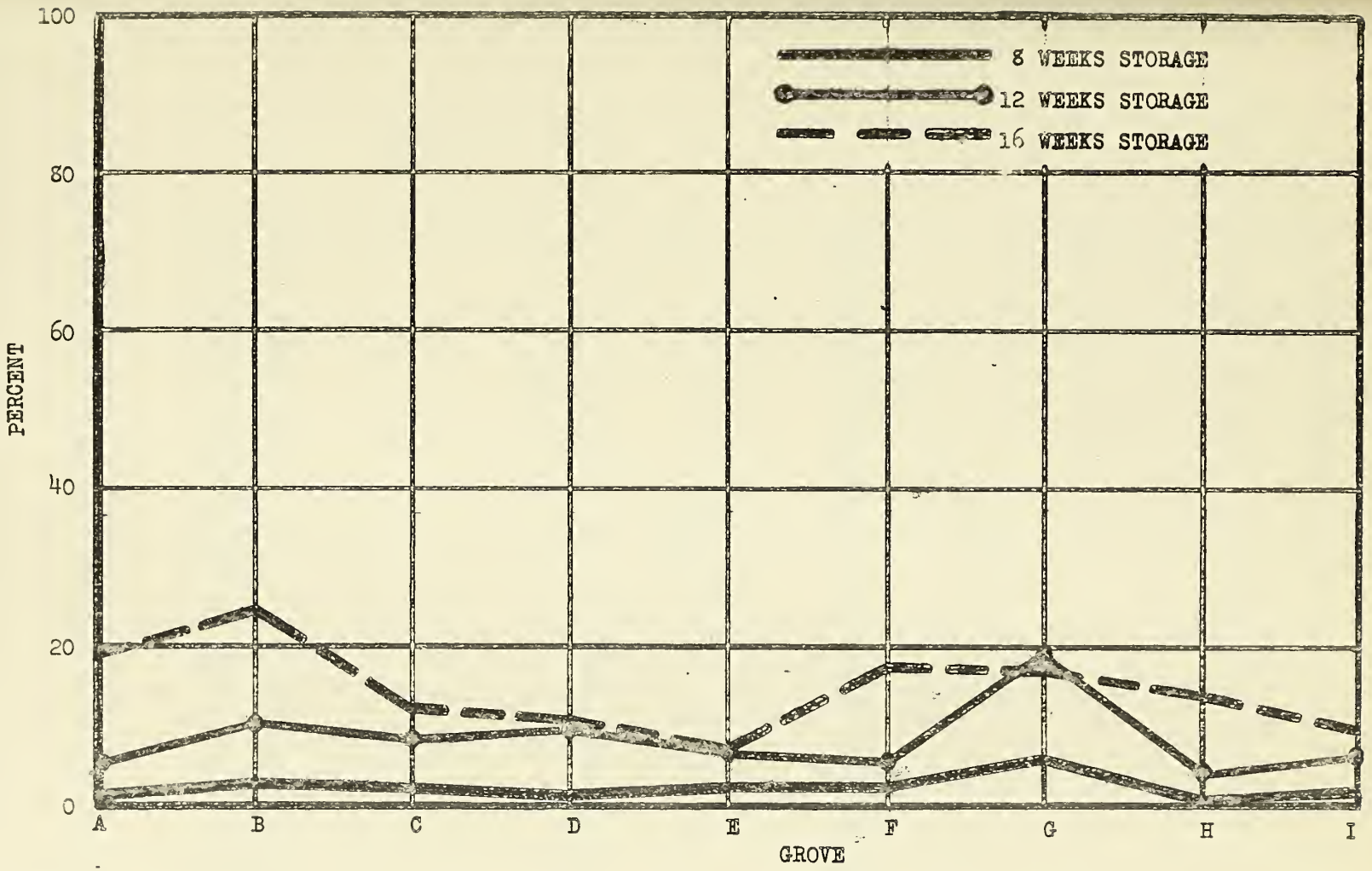

FIGURE 8.--EFFECT OF GROVE VARIATION ON DECAY AT 32° F. SECOND INSPECTION AFTER 3 DAYS AT 70° F.

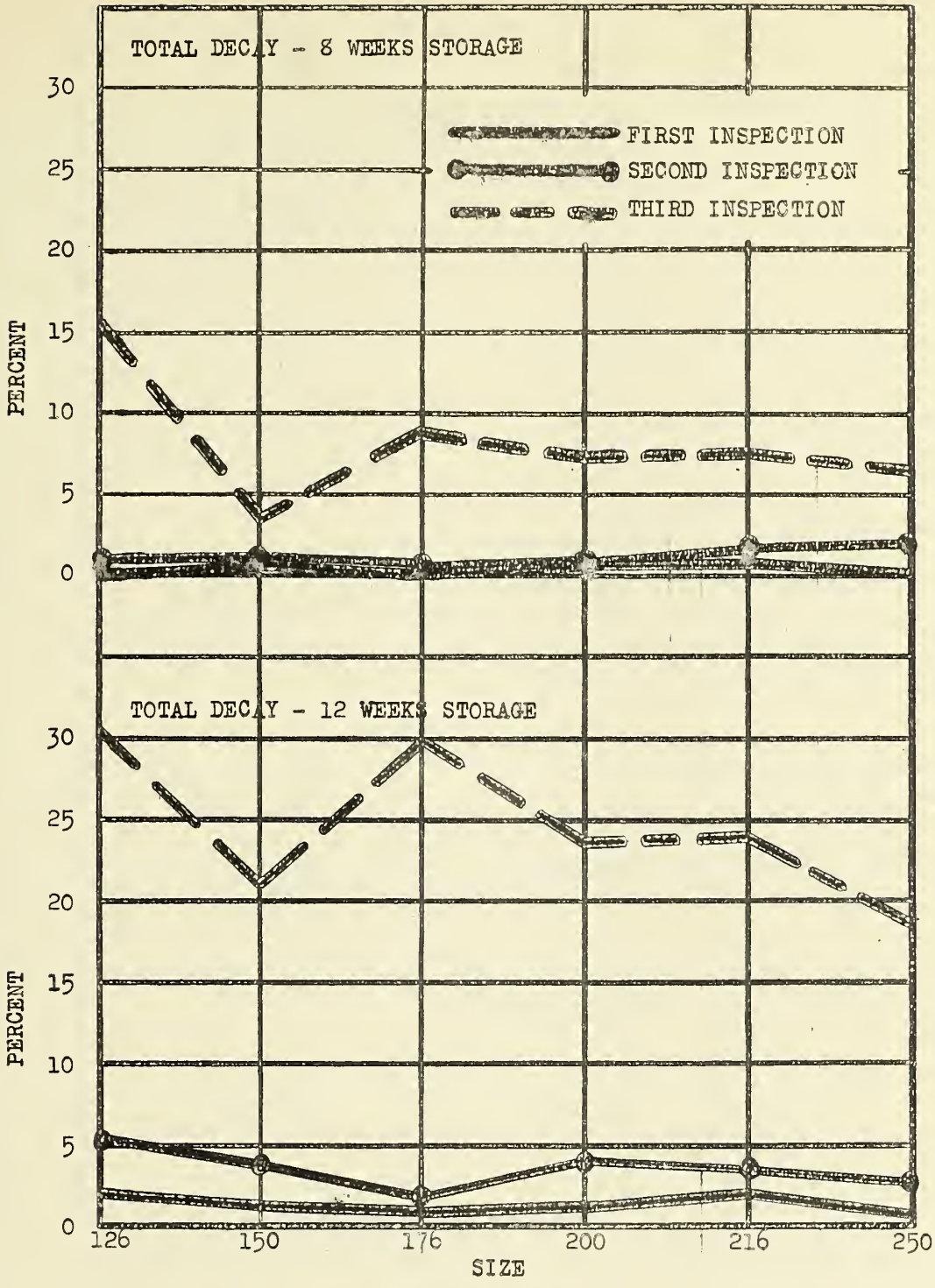

FIGURE 9.--EFFECT OF SIZE ON TOTAL DECAY AT 32° F. STORAGE. FIRST INSPECTION MADE AFTER REMOVAL FROM STORAGE; SECOND INSPECTION AFTER 3 DAYS AT 70° F.; THIRD INSPECTION AFTER 7 DAYS AT 70° F.

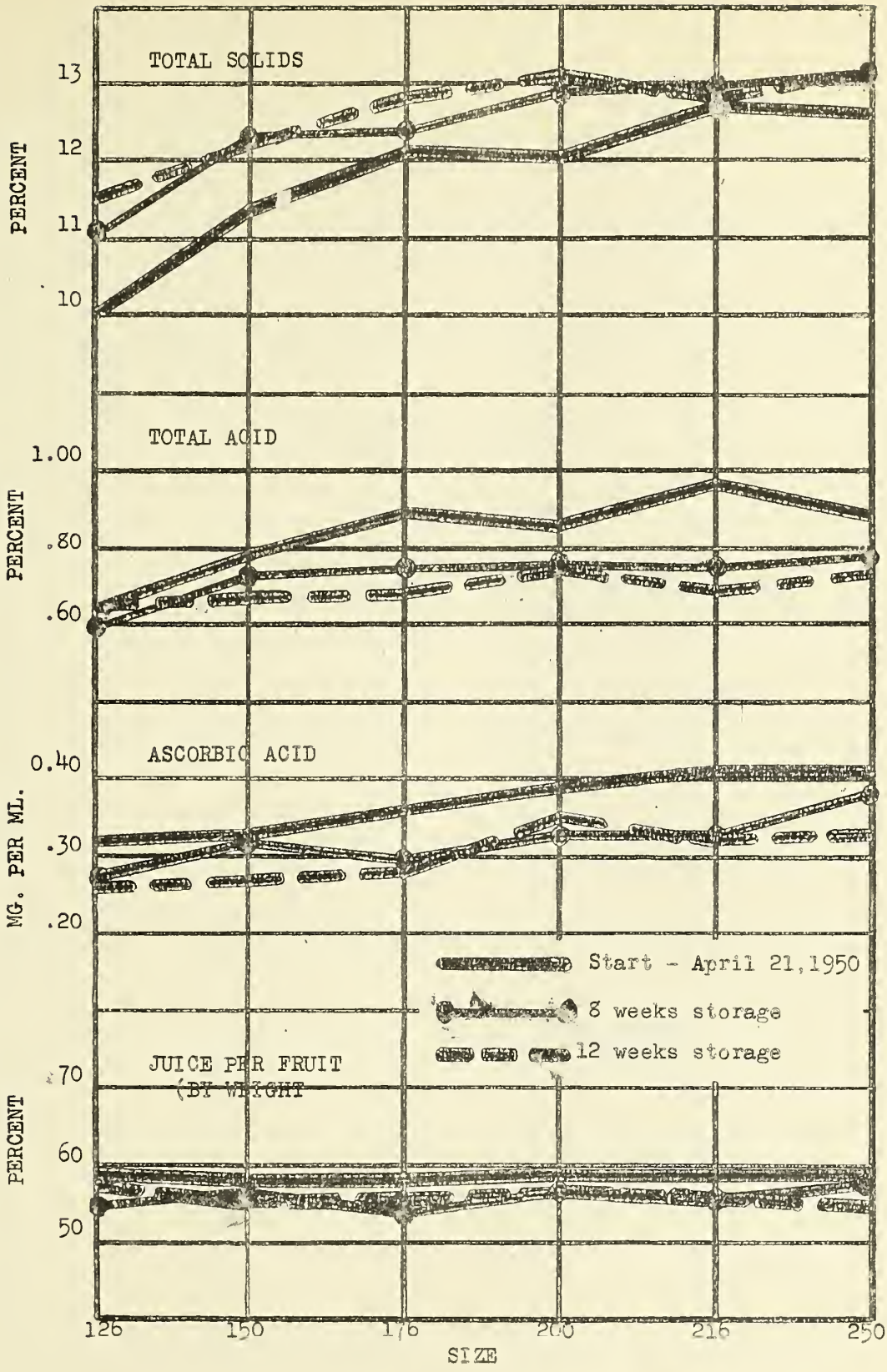

FIGURE 10.--EFFECT OF SIZE OF FRUIT ON THE COMPOSITION OF VALENCIA ORANGES STORED FOR 8 AND 12 WEEKS AT 32° F.

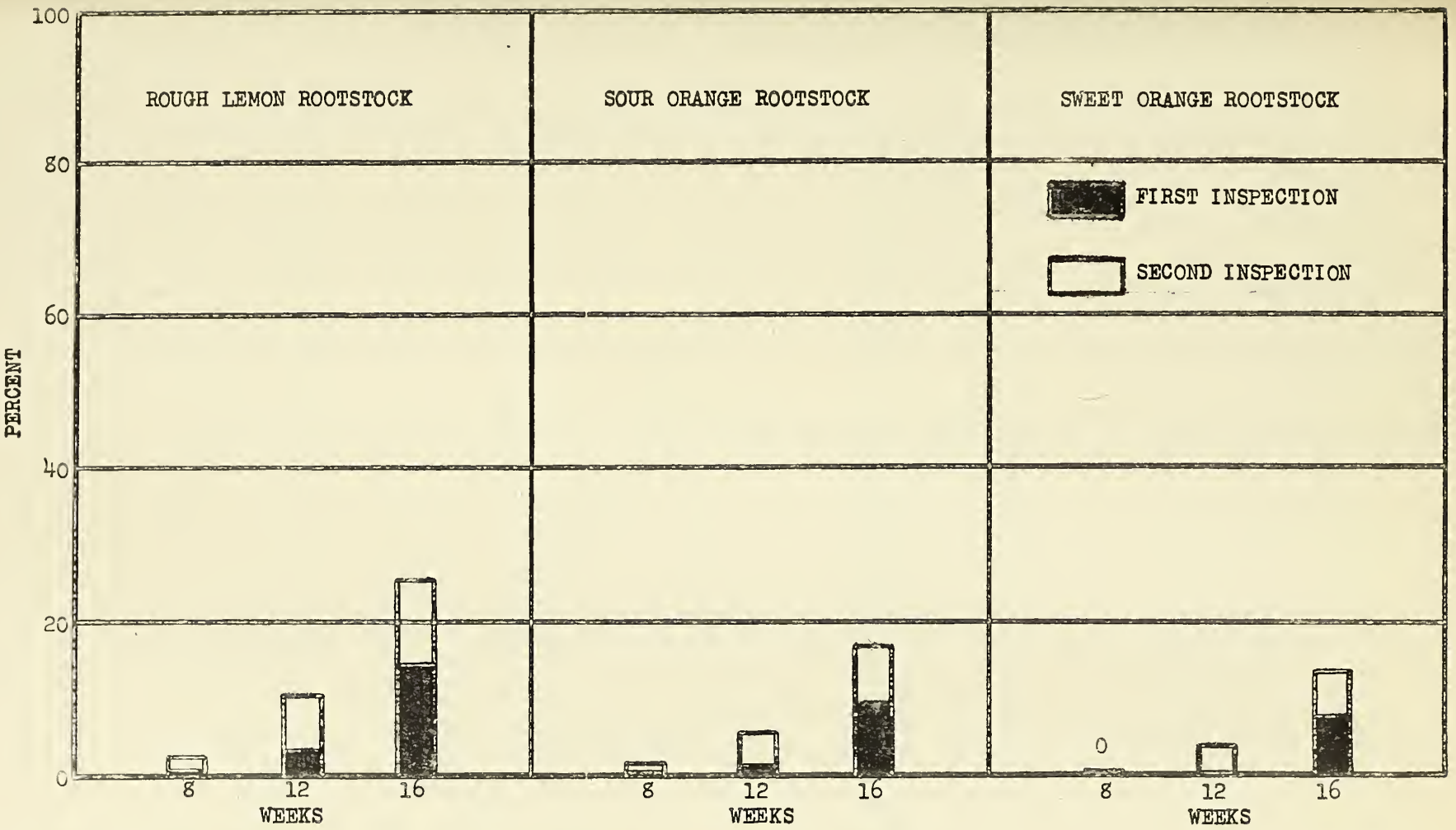

FIGURE 11.--THE RELATION OF ROOTSTOCKS TO DECAY OF ORANGES IN STORAGE AT 32° F.

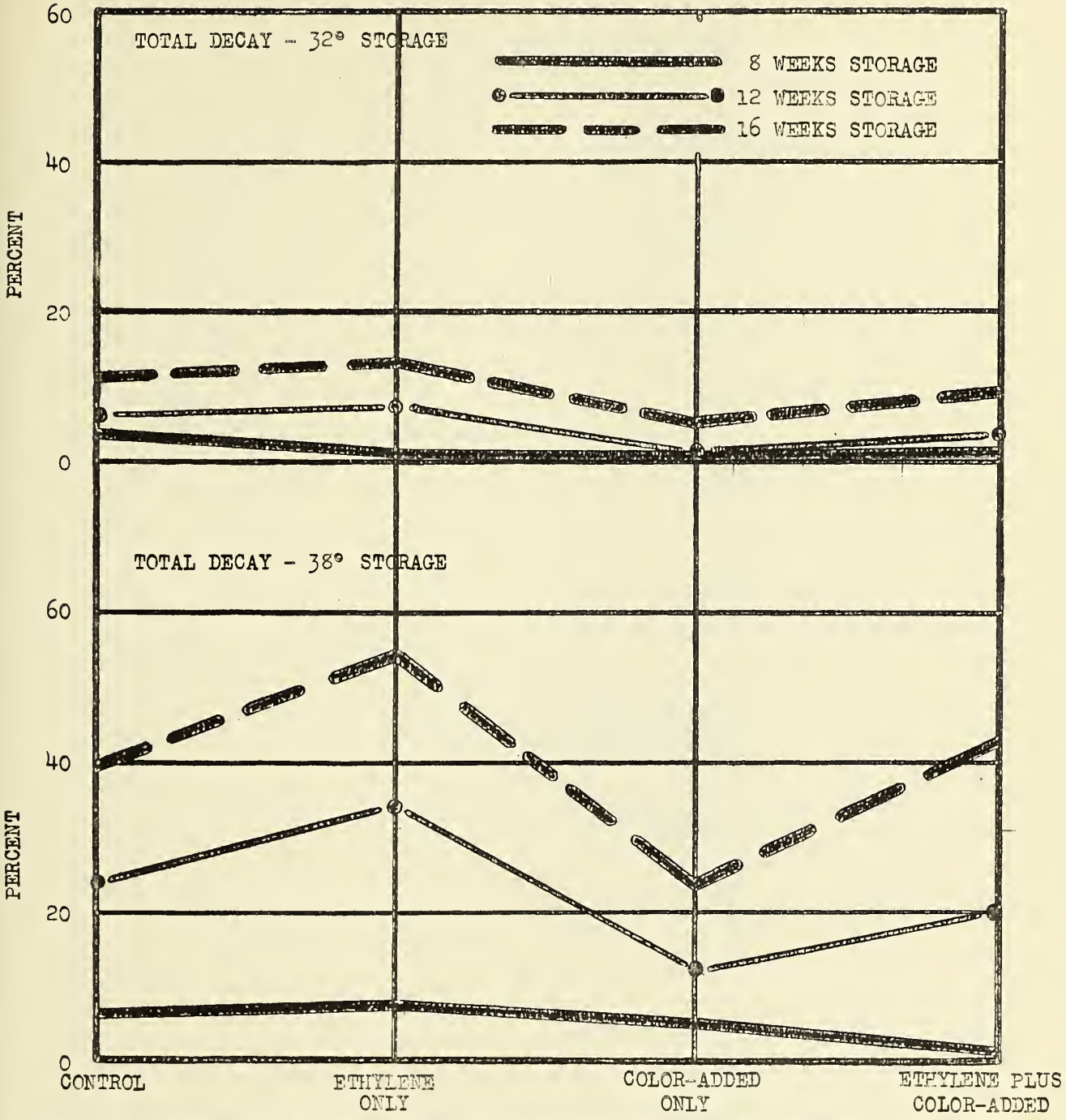

FIGURE 12.--RELATION OF COLOR-ADDED AND ETHYLENE TREATMENTS ON DECAY AT 32° AND 38° STORAGE, SECOND INSPECTION.

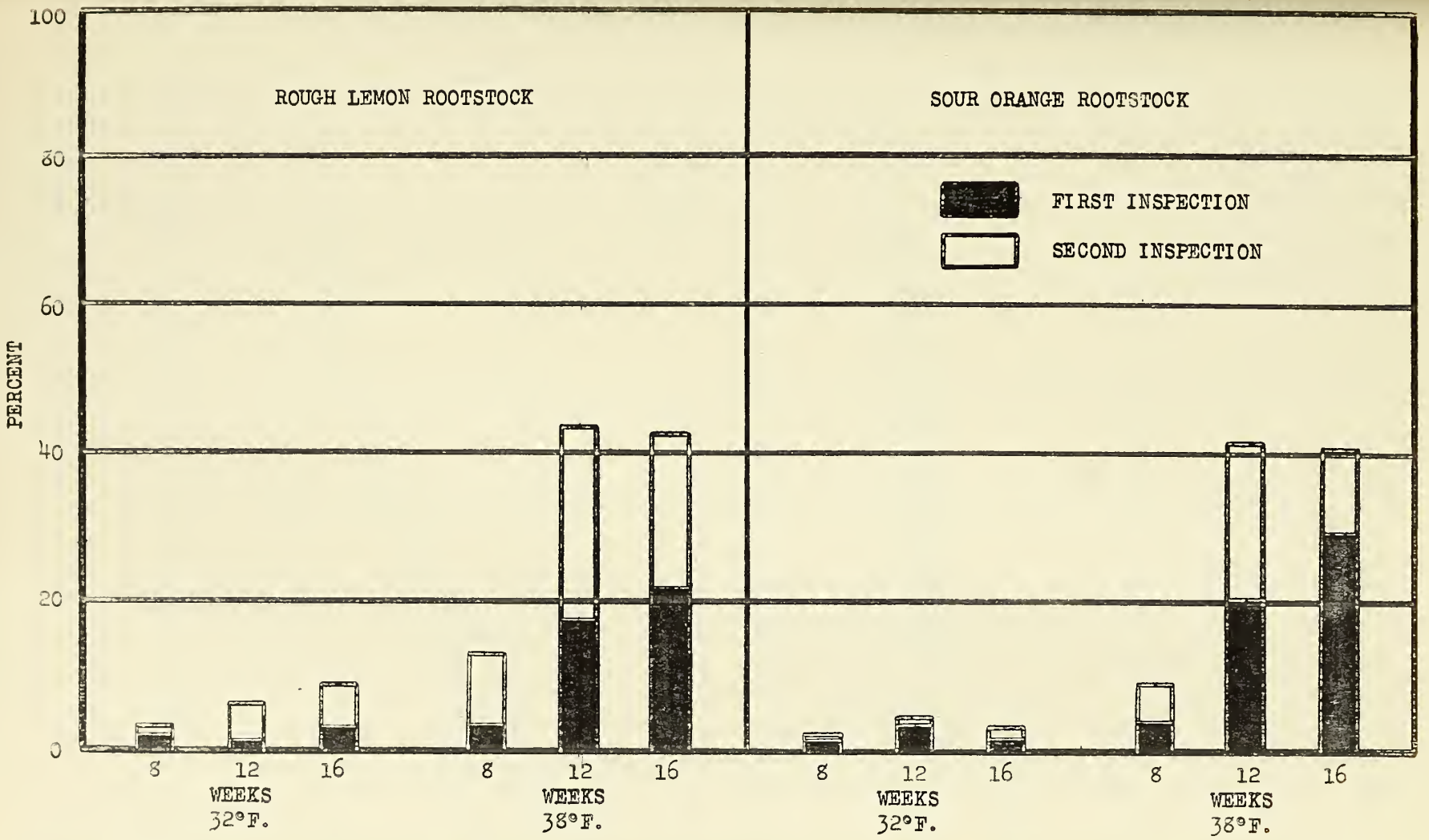

FIGURE 13.--EFFECT OF ROUGH LEMON AND SOUR ORANGE ROOTSTOCKS TO DECAY OF ORANGES IN STORAGE AT 32° AND 38° F.

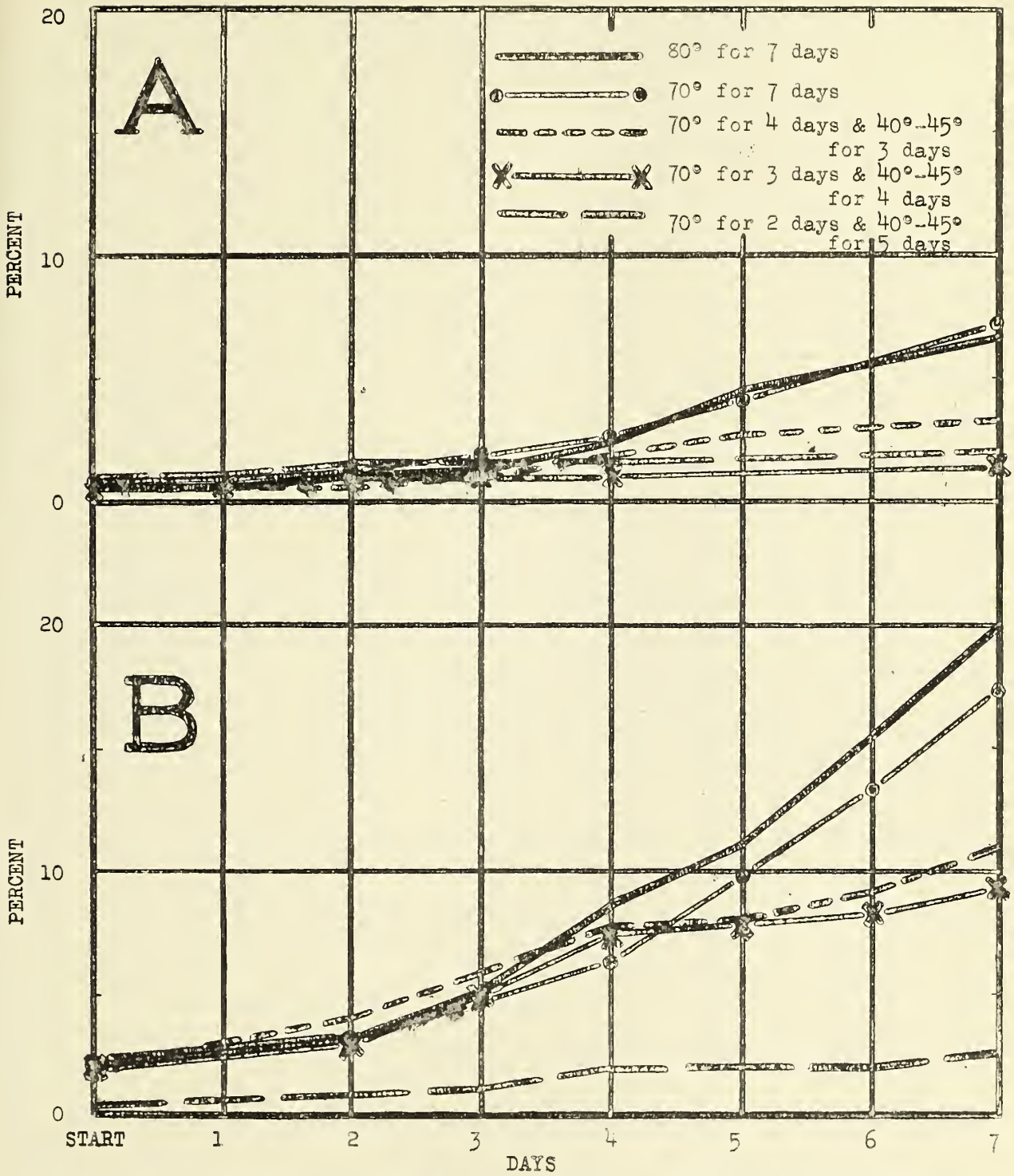

FIGURE 14.—RELATION OF HOLDING TEMPERATURE TO DECAY OF ORANGES AFTER STORAGE. A, AFTER 7 WEEKS STORAGE AT 32° F.; B, AFTER 14 WEEKS STORAGE AT 32° F.